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Technology-rich activities: One type does not motivate all

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ABSTRACT

We report on data collected at three time points during a four-day intervention designed to explore the value added of technology-rich activities within an inquiry mathematics curriculum. Two of the activities were computer-based, whereas the third involved a professionally created movie. Using latent profile analysis we explored (a) the profiles of experiences (indicated by self-reports of immersion, interest, usefulness, and relatedness of the technology activity) that students in Grades 5–8 (n = 7774) reported regarding their participation in one of three different activities; (b) the motivational and achievement outcomes in mathematics that were evident by being a member of one of these latent profiles; and (c) the factors that predicted students' membership into one of these profiles of technology experience. Results showed that: (1) three latent profiles emerged from the data; (2) the profiles predicted mathematics learning and motivation; and (3) grade level, prior mathematics achievement, prior mathematics interest, and students' feelings of how autonomy supportive their teachers are predicted membership into these profiles. Results support and refine the literature in educational psychology regarding models of motivation and engagement, as well as the literature in educational technology concerning the motivational affordances of technology.

1. Introduction

Researchers and practitioners often point to the use of technology-enabled instructional activities that employ constructivist pedagogical strategies as a key to engaging and motivating students in school (Blumenfeld, Kempler, & Krajcik, 2006). However, this assumption should not be taken as a given for a number of reasons, including factors such as how the activities are implemented by teachers (e.g., Wu & Huang, 2007) and whether the design and use of the technology-enabled activities might interfere with their willingness to engage with the content (Blumenfeld, et al., 2006). The specific type of technology that teachers use in classrooms will not necessarily determine the level of motivation and engagement that students experience—teachers can use a low-tech, low-cost, movie just as successfully as they can use high-tech, high-cost, games and simulations (Star et al., 2014). Thus, it becomes important to consider more nuanced questions about the specific *affective experiences* of students as they participate in activities rather than the medium (e.g., computer games versus movies). In fact, in our previous analyses of the same dataset using a variable-centered approach (Star et al., 2014) and only investigating changes from pre-intervention to post-intervention, we found that there was little to no effect of the technology activity that students participated in on outcomes such as self-efficacy and implicit theory of ability. There were very modest pre- to post-intervention changes on mathematics learning and value beliefs. These findings led us to consider the possibility that perhaps it is not the technology activity that makes a difference. Rather, it may be how students *experience* the technology that matters.

Unfortunately, evidence related to these issues is limited and contradictory (Moos & Marroquin, 2010). Like any pedagogical tool, technology can be designed and used in ways that facilitate or thwart students' engagement and motivation. Also, motivation and engagement are broad multi-dimensional constructs, such that technology-enabled activities may be successful in affecting some aspects of motivation and engagement but not others. These issues drive the present research, where we explore the variety of ways that technology-rich activities can engage and motivate students, and how students' experiences with the activity relate to their subject matter learning and motivation.

For the sake of clarity, we broadly define technology-enabled activities as those that involve some use of digital media. For our study in particular, we wanted to include digital media that spanned the spectrum from low interactivity and relatively low barriers for

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implementing (e.g., movies) to very high interactivity and relatively high barriers for implementing (e.g., immersive computer games). Also, because the terms engagement and motivation are often used interchangeably, we clarify how these constructs are defined and operationalized in the present study. Consistent with prior work on engagement (e.g., Furrer & Skinner, 2003; Skinner, Furrer, Marchand, & Kindermann, 2008), we broadly define engagement with technology as the degree to which students feel *immersed* in an activity and find the activity to be *interesting/enjoyable*. Drawing from the motivational literature (e.g., Eccles, 2009; Wigfield & Eccles, 2000), we define motivation as *beliefs about competence*, which answer questions like, "can I succeed?" and *beliefs about value*, which answer questions like, "why would I want to do this activity?"

The present research makes three unique contributions to the literature on engagement, motivation, and technology. First, as mentioned, scholars have noted the poor quality of empirical evidence investigating the affordances of technology-rich scholastic activities (Moos & Marroquin, 2010; Wouters, van Nimwegen, van Oosterndorp, & van der Spek, 2013). By using constructs drawn from rigorous theories of motivation and engagement, we investigated what affordances (if any) are provided by three different technology-rich activities that were tightly integrated into teacher-led, inquiry-based, mathematics instruction. Therefore, any differences in students' observed outcomes could be attributable to how students experienced the technology activity because everything else that students experienced was constant. Second, we drew from diverse literature bases to conceptualize salient aspects of motivation and engagement *within technology-enabled environments*. Although scholars have conceptualized the construct of engagement fairly broadly to encompass the dynamics that take place within a typical classroom (for a review see Fredricks, Blumenfeld, & Paris, 2004), we sought to explore engagement in a manner that was consistent with the nature of technology-enabled activities. Third, our interest here is in individual differences regarding students' motivation and engagement with technology-enabled activities. Rather than documenting whether computer games versus movies are associated with larger or smaller gains in motivation and engagement on average (e.g., Star et al., 2014; Annetta, Minogue, Holmes, & Cheng, 2009; Bai, Pan, Hirumi, & Kebritchi, 2012; Kebritchi, Hirumi, & Bai, 2010), we instead examined the patterns of motivation and engagement evinced by students, which represented their individual *affective experiences* with the technology activity, regardless of which one they participated in.

We asked three main questions. First, what patterns (i.e., profiles) of motivation and engagement emerge regarding students' experiences with technology? In particular, we focused on profiles regarding how *immersive*, *interesting,* and *useful* the technology activity was. We also focused on how *relatable* the characters were to students. Second, because the technology activities we used were integrated within a classroom-based mathematics lesson, we wondered what motivational and achievement outcomes in mathematics do students' technology engagement profiles predict, even as *all students* (regardless of technology activity) received the *same* teacher-guided, inquiry-oriented, mathematics instruction? Exploring this question would allow us to provide evidence for predictive validity regarding the profiles of technology motivation and engagement. Finally, because technology is not a one-size-fits-all solution for all students, we wondered which factors predict students' motivation and engagement with technology-enabled activities?

2. Engagement, motivation, and technology

Framing this study requires that we explore two literatures that are conceptually related. First, educational technology researchers have a long history of building technology activities that are designed to motivate and engage students. Second, there is a rich literature from educational psychology on how to motivate and engage students in school generally. The theories and empirical studies from this literature make predictions about how to design and use technology in classrooms to motivate and engage students.

2.1. Immersion and interest

Educational psychologists distinguish between fleeting moments of interest (referred to as *situational interest*) and more robust *personal interests*, which can be defined as a long-term and relatively enduring enjoyment in an activity such that individuals are likely to re-engage with this activity on their own accord (Hidi & Renninger, 2006). Hidi and Renninger describe interest development as a four-phase model that begins with a "hook" or triggered situational interest. This "hook" can then proceed to a *maintained situational interest* in which students maintain their initial interests and stay engaged with the activity, which can then lead to the development of personal interests.

Immersion could be framed within the interest development literature (Hidi & Renninger, 2006). It may be that immersive environments use immersion as a "hook" to spark students' initial interest in academic content (i.e., emotionally engage students). Immersion alone, however, cannot develop more robust personal interests, especially in a subject area. Rather, once students' interests are sparked, the content has to be interesting enough that students continually re-engage with it. This continual re-engagement with rich, high-quality, content, allowing for students to choose what they learn, and providing individualized feedback is one major affordance that technology-enabled activities can do easily.

When considering the educational technology literature, scholars in this field generally suggest that two features of technology-enabled activities play especially powerful roles in motivation and engagement. These features are immersion and interest (Goh, Ang, & Tan, 2008; Hainey, Connolly, Stansfield, & Boyle, 2011; Marsh, 2011; Squire, 2008). Immersion is defined within this literature as the subjective impression that one is participating in a comprehensive, realistic experience, such that individuals willingly suspend disbelief (see Hale & Stanney, 2015). Interest, on the other hand, is commonly conceptualized as enjoyment or fun.

Scholars in educational technology typically find that immersion facilitates positive academic outcomes (see Dede, 2009), and support the transfer of knowledge learned within a virtual context to a real-world context (Weinstein, Przybylski, & Ryan, 2009; Winn, Windschitl, Fruland, & Lee, 2002). The results linking immersion to learning outcomes notwithstanding, little research has been conducted concerning the *motivational* affordances regarding immersion despite the assumption that technology-enabled activities such as immersive virtual environments (IVEs) have motivational appeal due to their ability to create a physical and affective experience of "being there" (Dede, 2009). Some research has suggested that IVEs are effective when they incorporate a cohesive and compelling narrative, which facilitates learners' engagement (Barab, Sadler, Heiselt, Hickey, & Zuiker, 2007; Girard, Ecalle, & Magnan, 2013; Rowe, Shores, Mott, & Lester, 2010). Overall, the few studies investigating immersion (whether perceptual or narrative immersion) and motivation or engagement suggest that IVEs engage students by "suspending their disbelief" and thereby compelling them to participate in instructional activities.

With respect to interest, the literature also suggests that educational technologies that are perceived to be interesting and fun also facilitate positive student outcomes such as completing academic tasks (Allen, Crossley, Snow, & McNamara, 2014; Habgood & Ainsworth, 2011). Taken as a whole, the focus on interest and immersion points to a larger picture that scholars in educational technology mostly see computers as a tool to engage students in academic work—the more "time on task" in a learning environment, the more educational benefits students can gain. But a more important question (for educators) that has been addressed to a lesser extent is whether engaging in technology-enabled activities leads to increased engagement and motivation for the *subject matter*. Chen et al. (2016) showed that, students who experienced both